

Lemhi River Watershed TMDL



December 1999

An Allocation of Nonpoint Source Pollutants in the Water Quality Limited Watersheds of the Lemhi River Valley

Idaho Department of Health and Welfare

Division of Environmental Quality

1410 North Hilton

Bosie, ID 83706

Appendix B. Beneficial Use Reconnaissance Project Data

Site ID No.	Stream Name	Eco-Region	Elevation (Feet)	Stream Order	Rosgen Channel Type	Habitat Index Score	Macro-Invert. Index	%Surface Fines	Width/Depth Ratio	% Bank Stable		% Bank Cover	
										LB	RB	LB	RB
96-Z074	Agency Creek	NR	5924	2	A	83	4.54	20	10.3	100	100	4	94
96-Z075	Agency Creek	NR	5700	3	B	85	5.36	15	23.6	92	100	46	56
97-L082	Baldy Creek	SR	5035	2	A	83	2.97	71	18.9	90	90	44	50
97-L090	Basin Creek	NR	6470	2	B	118	4.14	52	7.9	83	94	92	91
96-Z079	Basin Creek	NR	8900	1	A	112	2.00	62	8.4	100	100	100	100
96-Z078	Basin Creek	NR	6420	2	A	94	4.67	45	16.8	89	85	89	89
97-L088	Basin Creek	SR	5525	4	G	109	4.32	30	12.1	90	100	62	70
97-M085	Bear Valley Creek	NR	6120	4	A	111	5.52	7	16.1	100	100	100	100
94-55	Big Eight Mile Creek	NR	7360	3	C	109	5.19	8	22	80	85	80	80
95-A078	Big Eight Mile Creek	NR	6880	3	A	95	4.71	29	14.9	100	96	64	68
95-B074	Big Eight Mile Creek	SR	5640	3	B	95	3.08	30	25.3	85	96	91	96
97-M129	Big Spring Creek	SR	5760	2	C	97	3.99	62	16.6	92	70	100	70
95-A077	Big Timber Creek	NR	6760	3	C	81	4.41	39	23.7	44	84	92	78
94-48	Big Timber Creek	SR	6400	3	B	104	4.67	3	38.3	70	80	75	70
94-54	Big Timber Creek	SR	6120	3	B	88	4.61	9	22.7	60	70	35	40
95-A115	Bohannon Creek	NR	5760	1	B	89	5.11	19	20.4	84	69	80	91
95-A116	Bohannon Creek	SR	4730	2	B	98	4.79	19	9.6	84	52	84	78
95-A118	Bohannon Creek	SR	4330	2	B	69	4.09	15	20.7	44	62	100	100
96-Z083	Canyon Creek	NR	6680	2	B	102	2.72	58	13.3	93	98	93	100
96-Z080	Canyon Creek	SR	6233	3	B	88	4.25	68	14.9	100	100	90	93
97-L081	Clear Creek	SR	7265	1	B	68	2.66	43	18.1	78	74	35	20
96-Z073	Cow Creek	NR	5513	2	C	99	4.30	74	10.1	86	100	97	100
96-Z084	Cruikshank Creek	NR	6680	3	B	87	1.72	59	18.9	97	100	91	73
96-Z016	Deer Creek	NR	6800	1	A	94	3.46	70	5	0	0	100	100
95-B026	Eighteenmile Creek	NR	8080	2	A	107	4.20	38	14.6	100	100	93	95
97-L077	Eighteenmile Creek	SR	6820	3	C	87	1.78	57	21	94	90	78	92
95-B044	Eighteenmile Creek	SR	6500	3									
94-53	Eighteenmile Creek	SR	6360	3	F	80	4.50	46	17.5	90	85	100	95
97-M087	Ferry Creek	SR	6220	1	F	50	4.84	41	6.8	100	40	96	100
96-Z011	Ford Creek	NR	6234	1	A	88	3.16	56	12.9	49	41	100	100
96-Z081	Frank Hall Creek	NR	7300	1	A	100	4.34	65	10.5	100	100	95	86
94-44	Geertson Creek	NR	7120	1	A	140		1	14.4	100	100	70	80
95-B045	Geertson Creek	SR	5240	2	B	91	5.32	44	8.5	82	77	42	43
95-A119	Geertson Creek	SR	4320	2	C	78	5.01	58	29.6	41	53	98	92
94-52	Hawley Creek	NR	6840	3	B	91	4.24	10	25.5	100	75	90	90
95-B042	Hawley Creek	SR	6480	3	F	95	4.00	33	19.1	100	97	98	100
94-51	Hawley Creek	SR	6080	3									
95-B043	Hawley Creek	SR	6080	3	B	53	1.78	13	26.4	100	94	0	4
97-M084	Hayden Creek	NR	6060	3	A	106	5.16	27	14.9	100	100	100	100
97-M083	Hayden Creek	SR	5410	5	B	106	5.73	9	26.9	95	90	100	100
97-M086	Hayden Creek E. Fk	NR	6080	2	A	119	5.15	38	12.8	100	100	100	100
97-L083	Haynes Creek	NR	6160	2	B	98	4.54	25	30.7	90	86	80	86

Lemhi River Subbasin TMDL

Site ID No.	Stream Name	Eco-Region	Elevation (Feet)	Stream Order	Rosgen Channel Type	Habitat Index Score	Macro-Invert. Index	%Surface Fines	Width/Depth Ratio	%Bank Stable LB	RB	% Bank Cover LB	RB
97-L084	Haynes Creek	SR	4790	3	A	104	4.26	51	14.1	90	86	31	24
96-Z012	Kadletz Creek	NR	6562	1	A	105	4.92	51	8.4	100	96	100	100
95-A043	Kenney Creek	SR	5000	2	A	89	5.31	42	19.6	85	90	60	50
95-A044	Kenney Creek	SR	4660	2	C	90	4.43	63	20	55	80	80	90
94-65	Kirtley Creek	SR	5160	1	C	90	5.67	6	28.1	35	35	75	65
94-64	Kirtley Creek	SR	4400	2	B	91	5.26	20	14.5	80	85	75	90
95-B075	Kirtley Creek N. Fork	NR	5960	1	A	103	4.92	16	19.9	100	100	100	90
97-M130	Lemhi River	SR	5760	4	C	77	4.42	27	29.8	100	55	100	55
97-M131	Lemhi River	SR	5660	4	F	91	4.23	14	26.3	100	100	100	100
97-M125	Lemhi River	SR	5190	4	B	98	4.46	12	17.1	100	98	100	98
97-M126	Lemhi River	SR	4220	5	B	104	3.97	11	35.9	100	100	100	100
97-M127	Lemhi River	SR	4080	5	F	92	2.79	9	51.4	100	100	100	100
97-M133	Lemhi River	SR	3910	5	B	87	6.57	4	53.8	100	100	100	100
94-56	Little Eightmile Creek	NR	6760	2									
95-A079	Little Eightmile Creek	NR	6590	2									
95-A101	Little Eightmile Creek	SR	6000	2	C	101	4.28	37	10.4	98	96	73	87
95-A114	Little Eight Mile Creek	SR	5700	2	A	79	3.82	33	11.4	100	100	100	100
97-L089	Little Timber Creek	SR	6780	2	B	88	4.60	40	26.8	77	92	82	94
97-L078	Little Timber M. Fork	NR	7440	2	A	109	4.14	28	11.6	62	80	72	53
97-L079	Little Timber N. Fork	NR	7435	1	B	112	5.14	29	22.1	100	100	100	100
95-A052	McDevitt Creek	NR	6680	2	A	105	5.22	37	7.4	90	85	75	55
94-47	McDevitt Creek	NR	6320	2	B	96	4.02	3	26.4	60	80	80	65
95-A042	McDevitt Creek	SR	5600	3	C	91	3.59	63	11.8	15	60	90	95
95-A053	McDevitt Creek	SR	5200	3	B	82	4.21	45	19.6	100	96	100	90
95-A045	McDevitt Creek	SR	5121	3									
94-49	Mill Creek	NR	7000	2	C	115	4.52	2	22.2	25	20	100	100
95-A051	Mill Creek	SR	6620	2	B	85	4.41	39	16.3	95	100	70	80
94-50	Mill Creek	SR	6040	2									
95-A080	Mill Creek	SR	5720	2	B	65	4.07	41	12.4	85	76	91	92
96-Z014	Mulkey Creek	SR	4335	1	B	56	3.58	87	5.2	0	0	98	100
96-Z077	Pattee Creek	NR	7500	1	A	96	4.42	45	29.7	100	100	98	98
96-Z076	Pattee Creek	NR	5310	3	B	87	3.85	33	12	88	100	4	72
98-D080	Pratt Creek	NR	5720	1	A	120		10	17.6	100	100	100	100
97-L087	Pratt Creek	NR	5880	1	G	115	4.59	23	29.1	69	76	98	100
97-L086	Pratt Creek	SR	4720	1	B	100	5.08	45	25.8	100	100	8	0
97-M082	Reese Creek	SR	5800	2	B	87	4.65	51	17.2	80	65	80	65
95-A054	Sandy Creek	NR	7920	1	A	84	4.15	30	15.6	98	100	4	4
94-45	Sandy Creek	SR	6040	1	A	97	3.00	12	10.5	95	90	90	95
95-A081	Sandy Creek	SR	4680	2	B	71	4.15	44	18.1	72	68	94	76
96-Z013	Short Creek	NR	6726	1	A	84	2.43	78	10.3	53	38	100	100
97-M078	Shroud Creek	NR	7605	1	B	105	5.57	41	6.8	80	80	80	90
97-L080	Tenmile Creek	SR	6575	1	B	93	3.16	62	7.8	100	100	100	100
97-M081	Texas Creek	SR	6120	3	B	74	4.62	23	15.2	100	100	100	100
96-Z015	Tobias Creek	NR	6780	1	A	91	3.65	62	9.4	0	0	100	100
97-M079	Walter Creek	SR	6120	1	B	93	3.01	55	5.1	100	100	100	100
97-L085	Warm Spring Creek	SR	5560	1	A	86	3.44	72	8.2	67	72	76	82
96-Z082	Wildcat Creek	NR	7020	2									
97-M080	Wildcat Creek	NR	7020	2	B	55	3.67	37	10.1	40	10	50	50
95-A082	Wimpey Creek	SR	4440	2	C	70	3.36	45	16.7	77	37	87	89
94-46	Wimpey Cr. E. Fork	SR	5000	1	D	86	6.20	22	37.5	95	90	85	95
95-A055	Wimpey Cr. W. Fork	NR	7520	1	A	111	4.60	53	13.1	100	100	100	100
97-L099	Withington Creek	NR	5460	2	B	105	2.98	30	21	88	90	100	98
97-L098	Withington Creek	SR	4500	3	C	105	5.14	65	11.7	90	80	60	43
97-M088	Yearean Creek	SR	5750	2	B	97	3.64	47	12	86	100	90	92

Water Quality Assessment Report Legend and Notes

Note: In addition to the Individual support status listings for beneficial uses listed in the report, Industrial Water Supply, Wildlife Habitat and Aesthetics are designated beneficial uses for all waters of the state. Due to the lack of established, objective criteria for these uses, they were not Individually assessed and are considered to be supported throughout the state for purposes of this assessment.

Abbreviations and codes used in the report:

Overall Status	FS - Fully supported, NFS - Not fully supported. NV- Needs verification, NA - Not assessed.																																						
Water Body	Geographic bounds of listed water bodies are headwaters to mouth unless specified otherwise.																																						
Site ID	Identifier assigned to the sampled sections of the water body. More than one Site ID may apply to the water body being assessed (some water bodies were sampled more than once).																																						
HUC	USGS Hydrologic Unit Code (physical watershed boundaries)																																						
MBI	MacroInvertebrate Biotic Index. A tool used to evaluate condition of water resources by using quantitative measurements of biological attributes that correlate well with human Influences. MBI evaluates communities of aquatic Insects and other Invertebrates living on the stream bottoms. Scores greater than 3.5 indicate non-impaired macroinvertebrate communities; scores less than 2.5 indicates impaired conditions. Scores between 3.5 and 2.5 need further. Scores are normalized (adjusted) based on ecoregional differences.																																						
HI	<p>Habitat Index A tool used to evaluate whether beneficial uses for support of aquatic life are being supported by using measurements and ratings of natural fish habitat conditions. HI scores used with MBI (and other indices if available, see below) to consider whether the water body fully supports the cold or warm water Biota beneficial use. Based on the range of conditions encountered so far for different ecoregions of the state (see below), habitat index scores are compared to the following variable scale:</p> <table> <tr> <th>Ecoregion</th><th>Impaired Conditions</th><th>Verification needed</th><th>Non-Impaired conditions</th></tr> <tr> <td>Northern Rockies</td><td><65</td><td>65-99</td><td>>99</td></tr> <tr> <td>Northern Basin and Range</td><td><57</td><td>57-85</td><td>>85</td></tr> <tr> <td>Snake River Basin/High Desert</td><td><59</td><td>59-88</td><td>>88</td></tr> <tr> <td>Middle Rockies</td><td><52</td><td>52-80</td><td>>80</td></tr> <tr> <td>Columbia Basin</td><td><53</td><td>53-85</td><td>>85</td></tr> <tr> <td>Wyoming Basin</td><td><71</td><td>71-88</td><td>>88</td></tr> <tr> <td>Wasatch and Uinta Mountains</td><td><77</td><td>77-95</td><td>>95</td></tr> <tr> <td>Blue Mountains</td><td><71</td><td>71-96</td><td>>97</td></tr> </table>			Ecoregion	Impaired Conditions	Verification needed	Non-Impaired conditions	Northern Rockies	<65	65-99	>99	Northern Basin and Range	<57	57-85	>85	Snake River Basin/High Desert	<59	59-88	>88	Middle Rockies	<52	52-80	>80	Columbia Basin	<53	53-85	>85	Wyoming Basin	<71	71-88	>88	Wasatch and Uinta Mountains	<77	77-95	>95	Blue Mountains	<71	71-96	>97
Ecoregion	Impaired Conditions	Verification needed	Non-Impaired conditions																																				
Northern Rockies	<65	65-99	>99																																				
Northern Basin and Range	<57	57-85	>85																																				
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Middle Rockies	<52	52-80	>80																																				
Columbia Basin	<53	53-85	>85																																				
Wyoming Basin	<71	71-88	>88																																				
Wasatch and Uinta Mountains	<77	77-95	>95																																				
Blue Mountains	<71	71-96	>97																																				
ECO	Ecoregions, regions with patterns of similar aquatic and terrestrial organisms and their environments. Used to assess realistically attainable quality for habitats and aquatic biological conditions. NR=Northern Rockies, NBR=Northern Basin and Range, SRB=Snake River Basin/High Desert MR= Middle Rockies, CB= Columbia Basin, WB=Wyoming Basin, WUM=Wasatch and Uinta Mts., BM=Blue Mountains (Omernik and Gallant 1986)																																						

Appendix C. Temperature Data

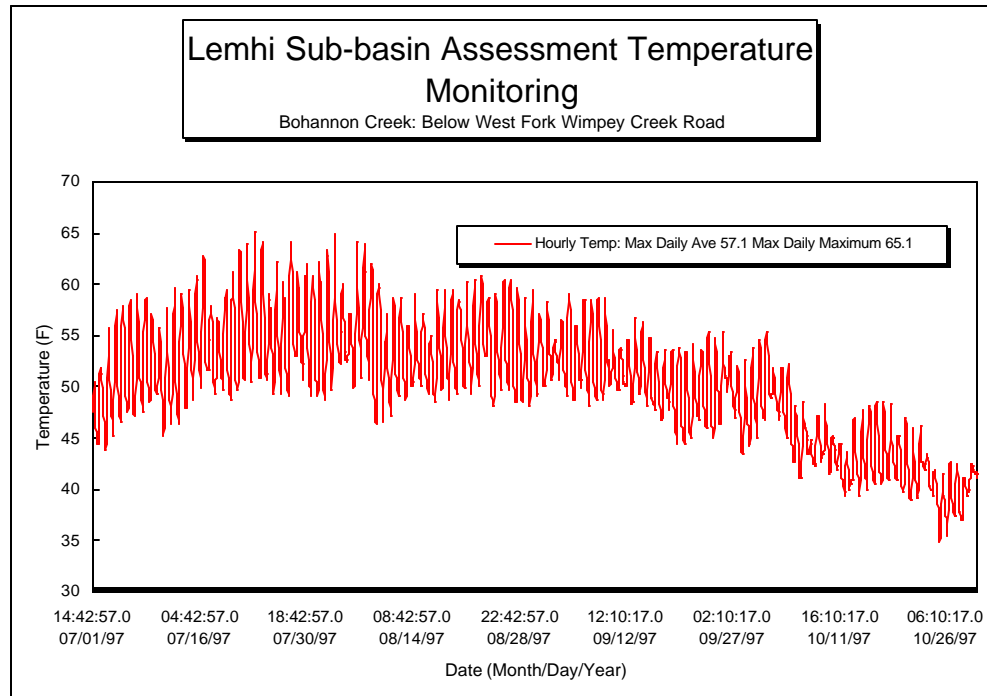


Figure C.1. Bohannon Creek temperature graph from 7/1/97 through 10/30/97.

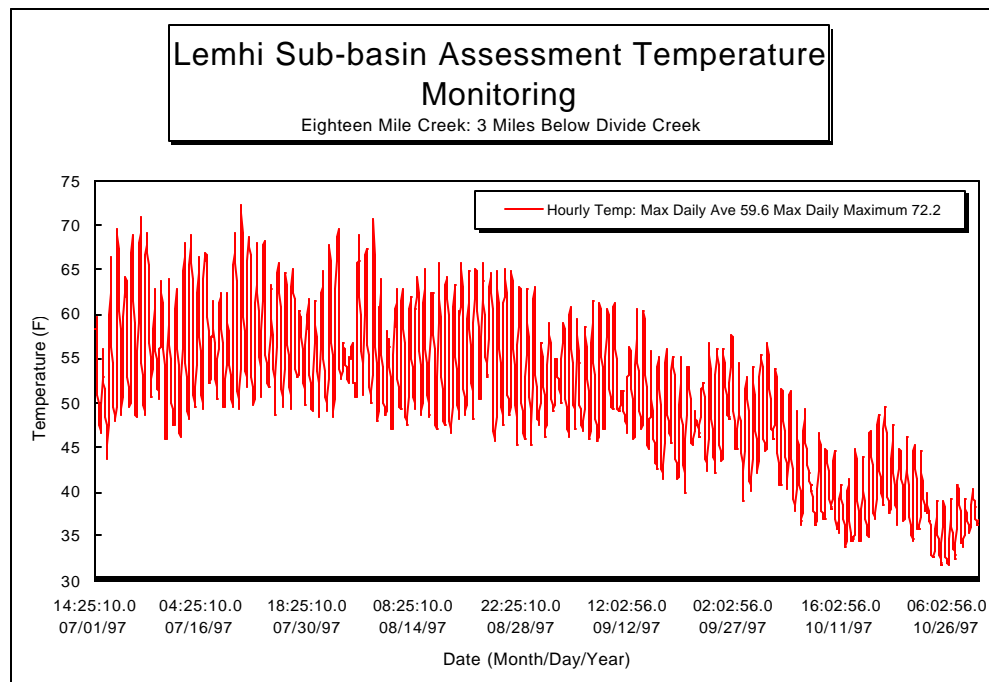


Figure C.2. Eighteenmile Creek temperature graph from 7/1/97 through 10/30/97.

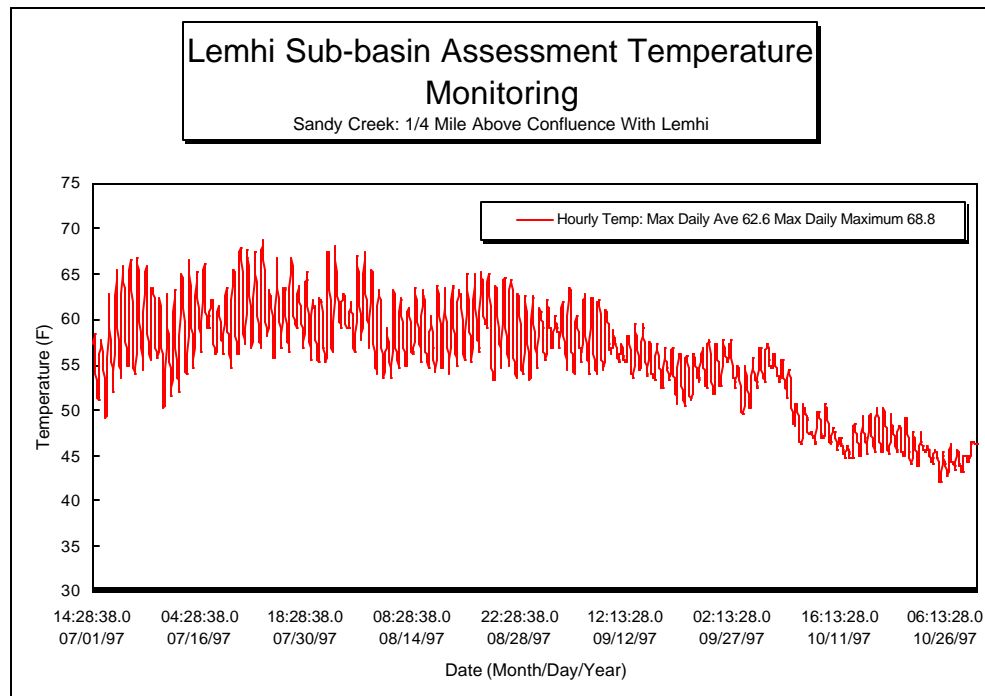


Figure C.3. Sandy Creek temperature graph from 7/1/97 through 10/30/97.

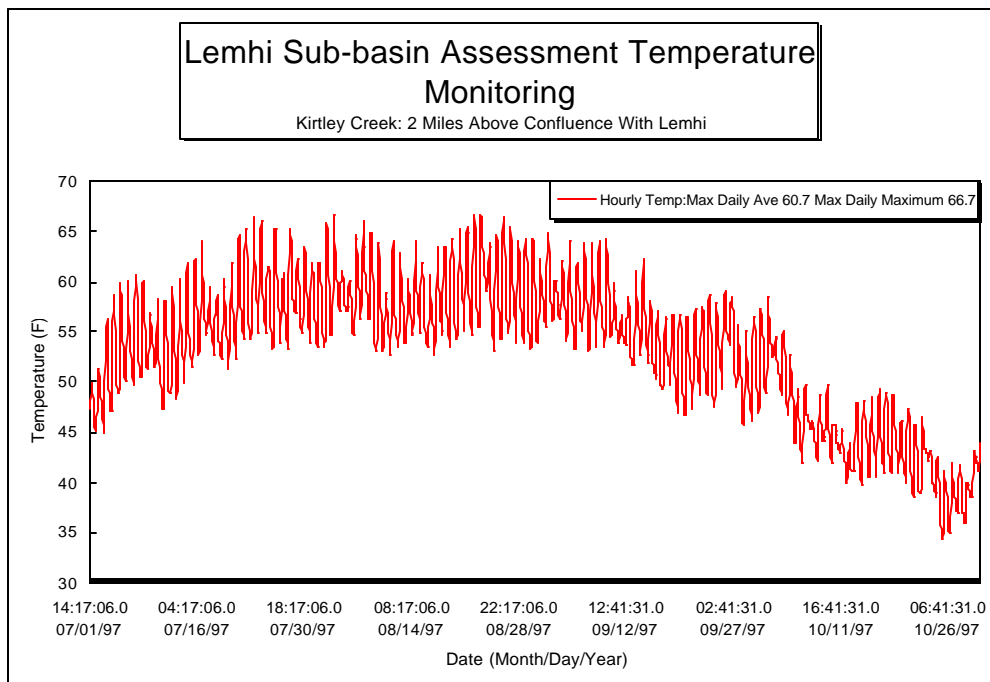


Figure C.4. Kirtley Creek temperature graph from 7/1/97 through 10/30/97.

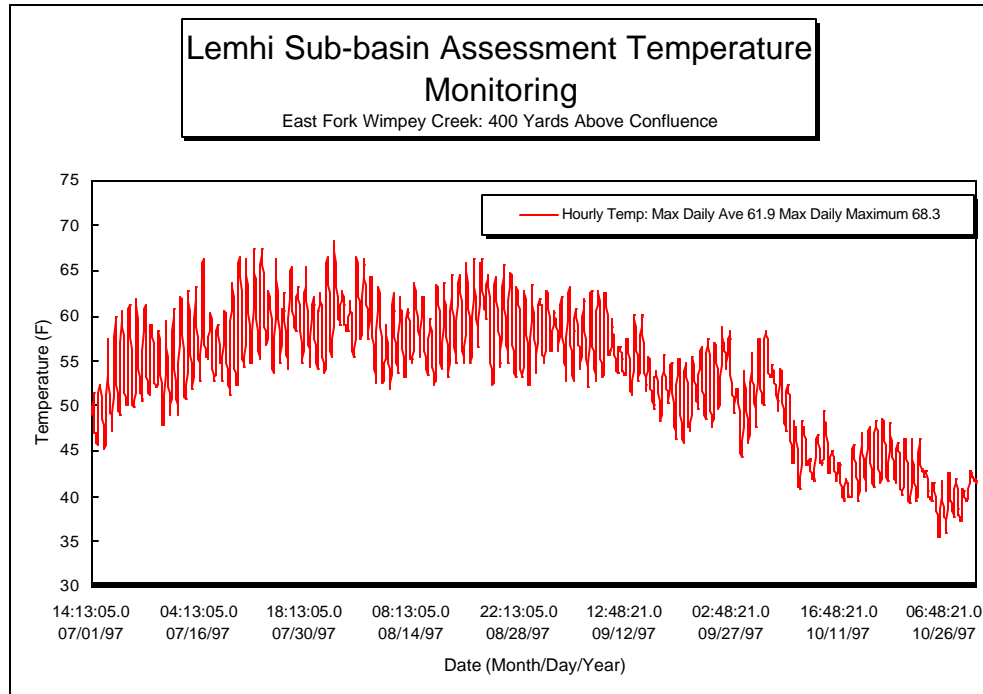


Figure C.5. East Fork Wimpey Creek temperature graph from 7/1/97 through 10/30/97

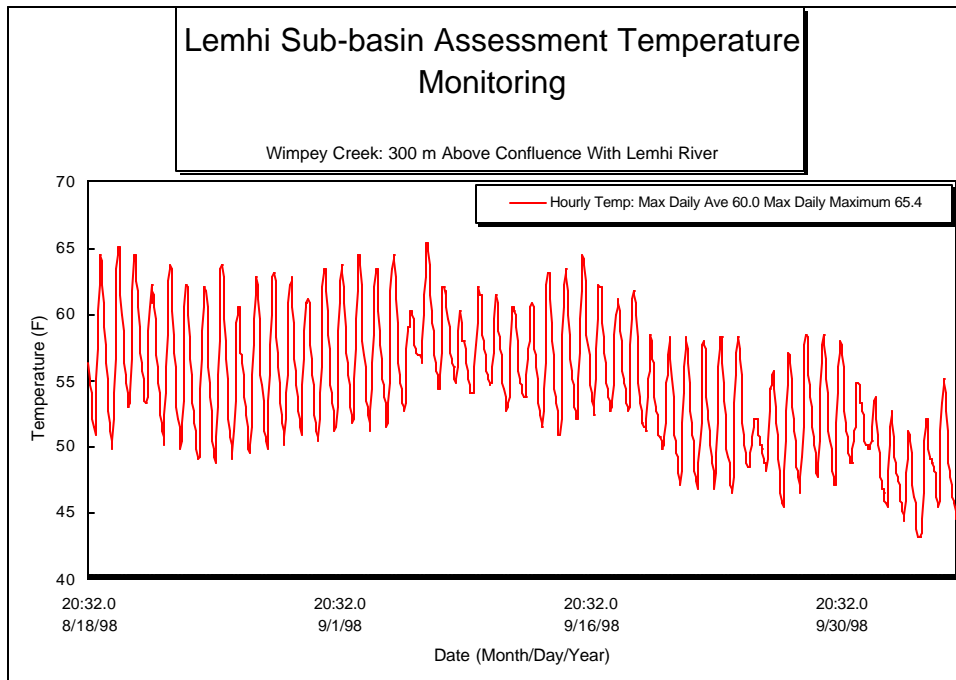


Figure C.6. Lower Wimpey Creek temperature graph from 8/18/98 through 10/7/98.

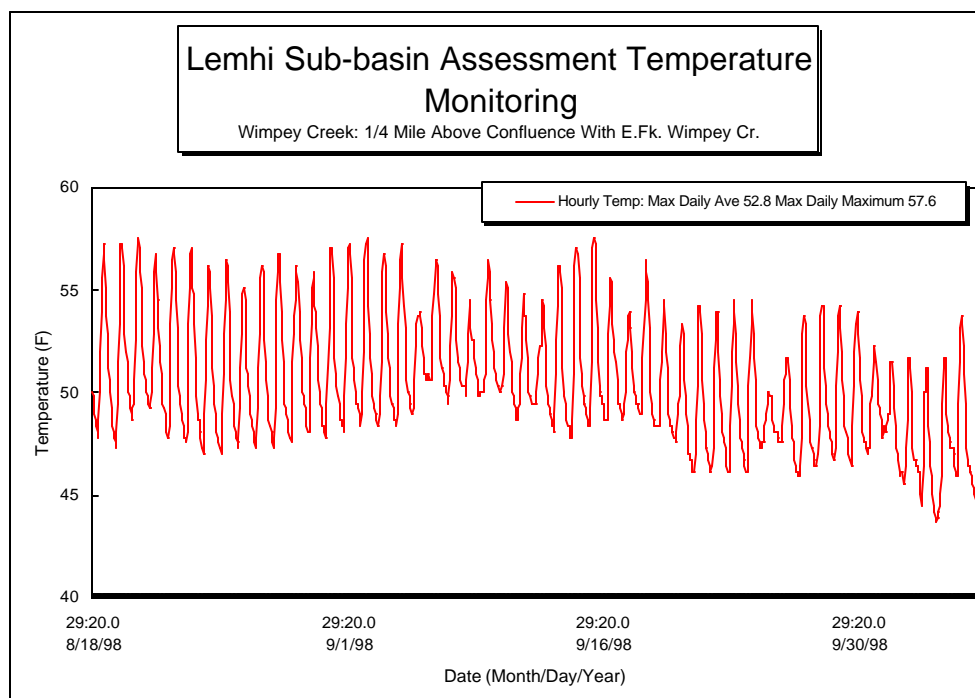


Figure C.7. Upper Wimpey Creek temperature graph from 8/18/98 through 10/7/98.

Lemhi River Subbasin TMDL

Table C.1. Thermograph Maximum Temperatures for the Lemhi
Sub-Basin 1993-1997 Supplied by BLM, USFS, and DEQ

	1993	1994		1995		1996		1997	
Stream Name	Max	Max	7-day Avg Max	Max	7-day Avg Max	Max	7-day Avg Max	Max	7-day Avg Max
Lemhi River									
Mouth	68.8	73.9							
Hayden	62.4								
Big Eightmile									
Lee Cr Road		66.2	64.1	62.4	58.7	64.4	62.1	62.7	59.9
BLM/USFS	56.5	61							
Big Timber									
Mouth		70.3	68.1	63	61.4	65	63.4	66.4	63.6
@ Basin Cr	60.7	68.2							
@ Grove Cr	58.1	59.3		57		60.4		61.9	58
Little Timber MF	57.6	61.8		61		50.4		59.6	58
Little Timber NF	52.9			53					
Swan Basin		68.5	67.1	63.2	61.2	66.5	64.9	64.9	62.8
Bohannon								65.1	62.9
Cruikshank						53.9		55	53.7
Eighteenmile									
Low		66.2	64	60.1	56.7	63	62	67.7	65.2
middle								72.2	68.1
Upper								64.2	60.6
Hawley	59.8	63.8		61		62.7		61.9	59.8
Reservoir	62.1			61		64.6		64.7	62.1
Big Bear (lo)	54.5	52.9		56		54		53.1	52
Big Bear (up)						60.1			
Geertson		56.5	55.2	52.9	48.8	53.4	52.7	55.9	55
Basin		68.9	66	67	64.8			69	66.1
Kenney									
Low		60.1	58.6	53.4	49.5	56.5	55.2	57.8	56.4
Upper				52	48.4			52.3	51.6
Kirtley									
Main								66.7	65.6
North Fork								53.2	52.7
Little Eightmile									
Lower									
Upper	57.6	58.7				57.3		57.3	56.1
McDevitt									
Low		63	62.4	60.4	59.2	61	60.1	59.6	58.4
Upper								49.7	48.5
mill	52	53.4		51		50.6		49.5	48.6
Sandy									
Texas								67	64.2
Wimpey									
East Fork								68.3	66.1
West Fork								53.9	52.8

Appendix D. Bacteria Data



Lemhi River Subbasin TMDL

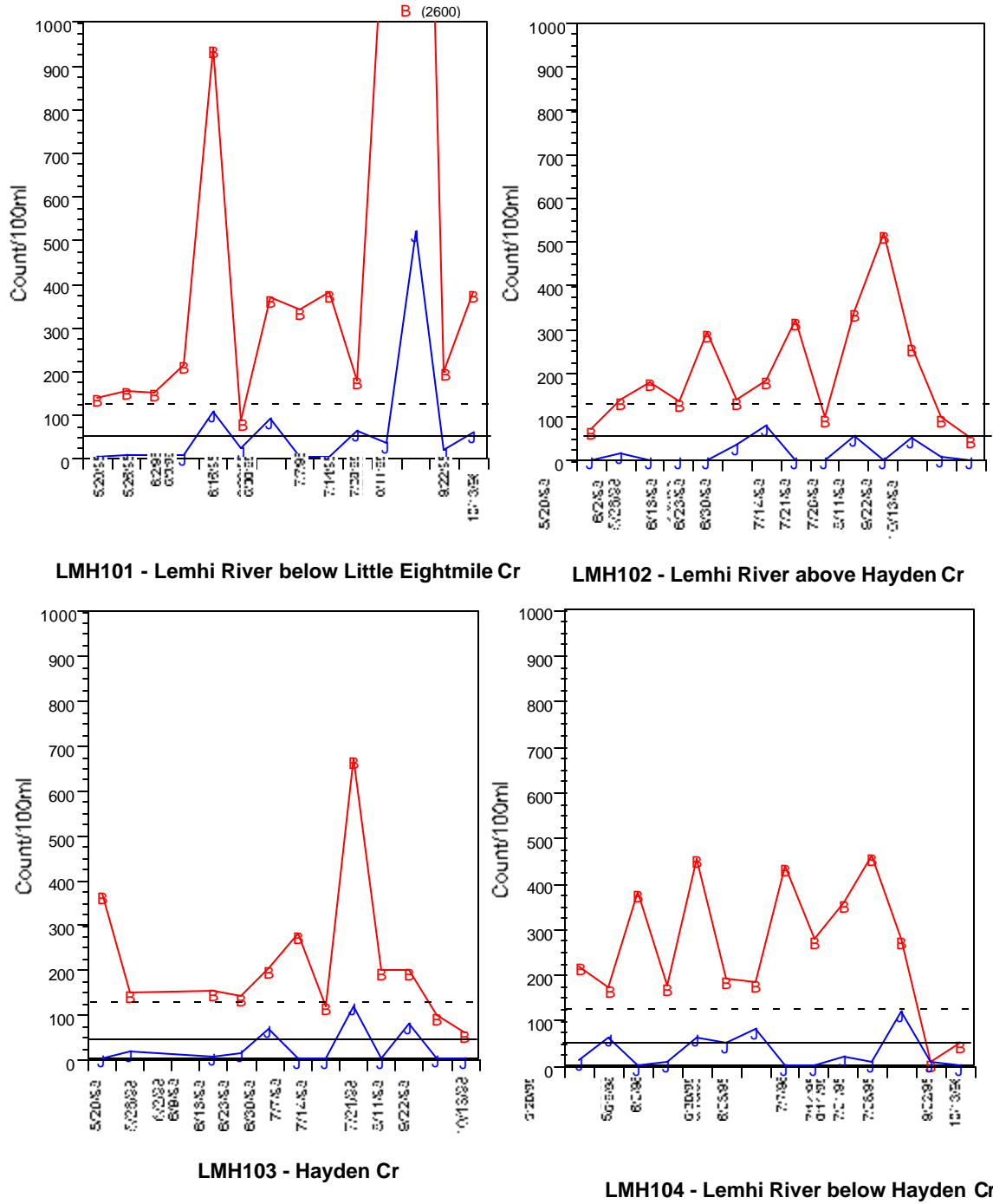
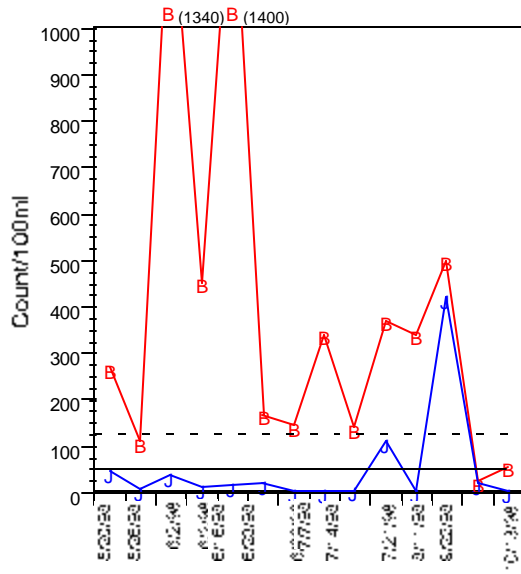
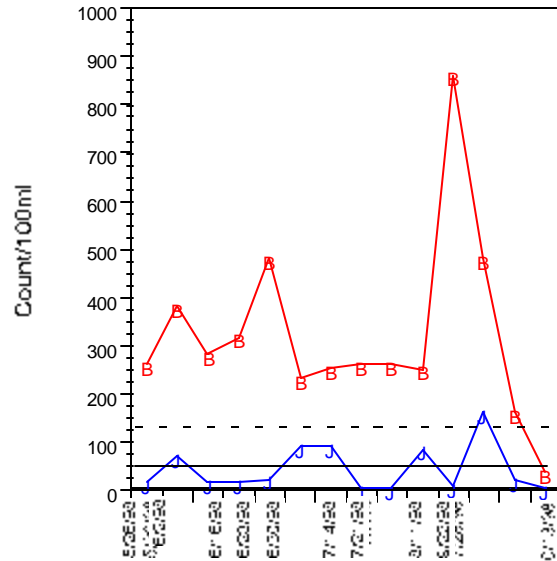


Figure D-2. Comparison of fecal coliform and E. coli bacteria counts at Lemhi River stations.

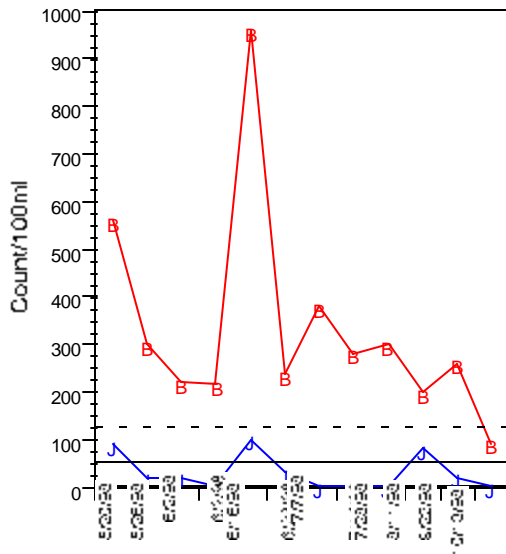
Lemhi River Subbasin TMDL



LMH105 -S. of Agency Cr



LMH107 - Lemhi R at Barracks Lane Road



LMH109 - Lemhi River@ Salmon (St Charles Br)

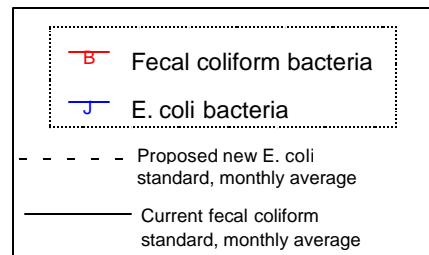


Figure D-2 (cont.) Comparison of fecal coliform and E. coli bacteria counts at Lemhi River stations.

Appendix E. Aerial Photos

Photos not included due to the inability to reproduce them legibly. Please contact Troy Saffle at Idaho Department of Environmental Quality, 900 N. Skyline, Suite B, Idaho Falls, Idaho 83402 or by calling (208) 528-2650 to receive these images.

Appendix F.

Sediment trace metals analysis, Kirtley Creek, Lemhi subbasin, Idaho

Chris Mebane, Idaho Division of Environmental Quality, Idaho Falls, ID

Jim Fitzgerald, EPA Idaho Operations Office, Boise Idaho

Background

Kirtley Creek was listed by EPA in 1994 on the Clean Water Act §303(d) list of water quality limited streams. EPA's listing was based upon Appendix D of the 1992 Idaho Clean Water Act §305(b) report which listed the beneficial uses of salmonid spawning and cold water biota to be "partially impaired" due to metals and sediment due to placer mining. No analysis of any media was reported to determine impairment by metals. Instead, this was an "evaluated" assessment, based upon the presence of placer mining. No site specific data was used in the assessment (IDEQ 1989, 1992).

There have been anecdotal reports of mercury amalgams used to extract gold from placer concentrates in the Kirtley Creek placer operation. Synoptic water sampling in 1997 above and below the placer operation did not detect mercury or any other criteria metals increase below the site. (Table F-1a and b).

Table F-1a Metals concentrations and applicable criteria for Kirtley Creek, 10/30/97 (in µg/l, "dissolved" (0.45 µm filtered) concentrations)

	Antimony	Arsenic	Cadmium	Copper	Iron
Upper Kirtley Creek	<5	<10	<1	<10	11
Lower Kirtley Creek	<5	<10	<1	10	94
Criterion Maximum Concentration (CMC) for protection of aquatic life		360	1.4	7.2	
Criterion Continuous Concentration (CCC) for protection of aquatic life		190	0.5	5.2	
Human Health Criteria	4300	50			

Table F-1b Metals concentrations and applicable criteria for Kirtley Creek, 10/30/97 (in µg/l, “dissolved” (0.45 µm filtered) concentrations)

	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Upper Kirtley Creek	>5	2	<0.5	<5	<1	<2
Lower Kirtley Creek	>5	115	<0.5	<5	<1	<2
Criterion Maximum Concentration (CMC) for protection of aquatic life	23.5		2.0	20	0.7	53
Criterion Continuous Concentration (CCC) for protection of aquatic life	0.9		0.012	5		48
Human Health Criteria			0.05			

However, one-time water column sampling is not conclusive, and reviewers suggested sediment trace metal analysis as a more conclusive approach to determining whether anthropogenically enriched mercury concentrations occur which could potentially have adverse effects to aquatic life. The use of trace metal sampling has been successfully used in minerals exploration and environmental surveys locate sources of metals enrichment. Mercury and other trace metals concentrations in water column are typically very low, whereas concentrations in sediment are typically an order of magnitude higher. Sediments are also an integrative measure of metals occurring in the water column, and are much more persistent than concentrations in the water column. No regulatory criteria for mercury in sediments apply to protect aquatic life. Instead, results may be evaluated by comparing to baseline conditions or to non-regulatory benchmarks of thresholds of effects to aquatic life (Horowitz 1991, Long et al. 1995). Development of numerical sediment quality values has been technically difficult and controversial. No consensus methodologies exist to estimate the likelihood of biological effects from sediment sorbed metals.

Fine-grained sediments typically sorb the highest concentrations of metals. Sieving sediments through a 63 µm mesh is recommended by the USGS programs to improve comparability of results by avoiding comparing results from coarse and fine grained sediments (Horowitz 1991). This approach developed through the field of economic geology and USGS geochemistry surveys to track minerals in stream sediment surveys to their source ores. This approach is continued through the USGS National Water Quality Assessment Program. Standardizing grain sizes in this manner reduces the variability of results and improves the ability to identify contributing contaminant sources by comparing relative sediment chemistry values in relation to potential sources.

However, sieving sediments before analysis confounds interpretation of potential biological effects. Macroinvertebrate infauna in the stream are exposed to a mixture of grain sizes, not just those that pass through a 63 µm mesh. The bioavailability of sediment sorbed mercury is inversely correlated to the organic content of the sediments

(Beckvar et al. 1996). Fine-grained sediments tend to have higher organic contents and higher metals concentrations than coarse grained sediments, yet sieving can affect the organic content. An approximation of whether mercury concentrations in sediment are a biological risk can be made by targeting sand and silt sized fine grained sediments from depositional areas of the streams.

After considering these factors, we decided to conduct a reconnaissance of mercury in Kirtley Creek stream sediments. The objectives of the survey were to:

- 1) Determine whether mercury concentrations in sediments are higher downstream of placer mined area than upstream
- 2) Determine whether mercury concentrations in sediments occur at concentrations higher than benchmarks of adverse effects to aquatic life.

If the results of both objectives were affirmative, then the site would be recommended for further analyses to determine the extent, severity, and bioavailability of contamination. Otherwise, no further investigations would be recommended.

While the stated concerns focused on potential mercury contamination, the sediments were analyzed for other metals which a consulting geologist (E. Modroo, P.G., IDEQ) suggested could be regionally elevated in that geologic formation, and are also of potential concern for aquatic life.

Methods

Sediments in Kirtley Creek were collected and analyzed per the sampling and analysis plan of August 13, 1998. Relevant details from that plan follow (Table F-2).

Fine sediments were sought in quiescent areas of the streams at the following key locations in the drainage. These fines were located along the stream margins, in pool tailouts, and at the tails of point bars. The fine sediments would be collected by a scoop, targeting the upper 2 cm of sediment.

Table F2. Sampling locations

Sample Locations	Station	Description and Rationale for selection
Upper Freeman Creek on the Salmon National Forest	F-1	Provide regional mineralized background, similar geology, no significant mining disturbance
Kirtley Creek on National Forest	K-3	Provide upstream background value
Kirtley Creek in placer spoils area	K-2	Test site
Kirtley Creek in placer spoils area	K-1	Test site
Kirtley Creek near residence	K-4	Test site - short distance below placered area
Kirtley Creek near county road	K-6	Test site - determine is attenuation with distance

Sampling methodology

Samples were be collected by spatula depositional areas over a 100m reach at each of the locations in Table 1. Samples will be composited and split in two portions. One portion will be sieved at 63 μm into polyethylene jars. The other portion will be stored without sieving. Sieves will be rinsed with ambient water between each sampling. One field split will be placed in a container and submitted to the laboratory as a blind duplicate.

Samples were analyzed by the Inorganics section of Idaho State Laboratory, Boise. The samples were dried and digested using EPA method 245.5 section 8.2 and analyzed for mercury using the cold vapor technique. Separate portions of the samples were weighed and digested using EPA method SW846 3050B. Arsenic was analyzed by graphite furnace atomic absorption and the remaining metals were analyzed by direct aspiration atomic absorption. The method resulted in the least reportable detection limits listed in Table F-3.

Table F-3: Analytical methods and estimated method detection limits

Analyte	Method	Approximate method detection limit (mg/kg)
As	ICP (Inductively coupled plasma)	1
Cu	ICP	2
Hg	CVAA (Cold vapor atomic absorption)	0.25
Pb	ICP	10
Zn	ICP	1

Results

Results of the bulk sediment samples showed that bulk sediment concentrations in Kirtley Creek were low, and near or below the minimal-effects ranges (ER-L). There was no increase between concentrations upstream and downstream of the mined area (Table F-4, Figures F-1 and F-2). The highest metals concentrations occurred in the mineralized and sieved sediment samples are shown in Table F-5

Table F-4. Concentrations of metals in Kirtley Creek bulk sediment samples (mg/kg dry weight) and sediment quality values.

Location	Station	Type	As	Cu	Pb	Hg	Zn
Freeman Cr (reference)	F-1	Bulk	3.3	19	308	0.42	25
Upper Kirtley, at confluence	K-1	Bulk	1.1	39	16	<0.25	23
Middle Kirtley, at lower placer	K-2	Bulk	2.7	38	27	<0.25	34
Middle Kirtley, below placer	K-3	Bulk	3.2	46	27	<0.25	40
Lower Kirtley, above road	K-4	Bulk	1.4	17	16	<0.25	19
Lower Kirtley, below road	K-6	Bulk	3.6	43	29	<0.25	39
Biological effects unlikely (ER-L)		Bulk	8.2	34	47	0.15	150
Biological effects probable (ER-M)		Bulk	70	270	218	0.71	410

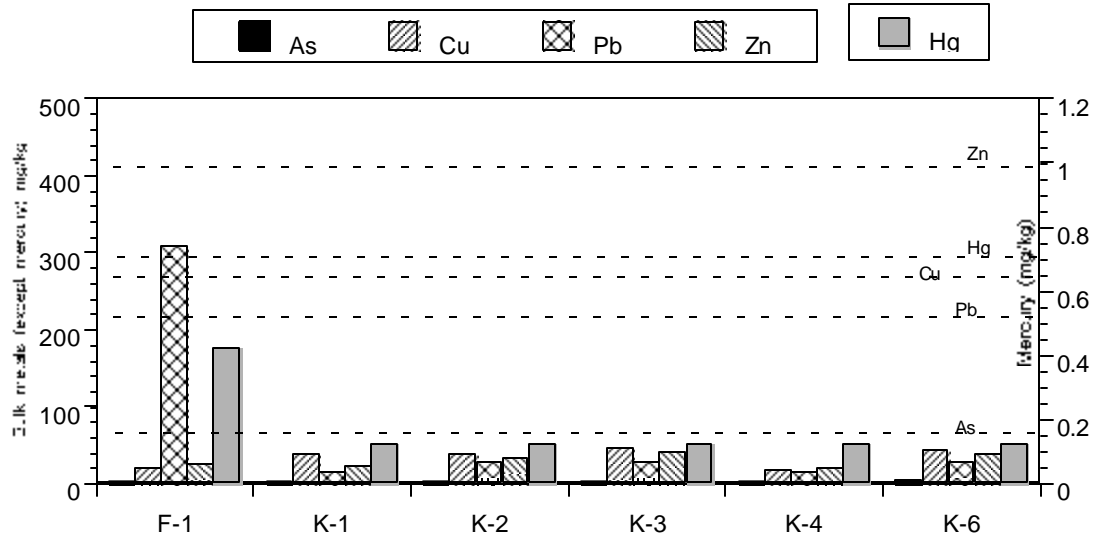


Figure F-1. Potential biological effects thresholds and distribution of bulk metals in sediments from locations in the Kirtley Creek watershed and from unmined upper Freeman Creek (reference). Dashed lines indicate selected sediment quality guidelines ER-Ms, effects ranges-median. Adverse biological effects were probable at concentrations above ER-Ms in the development of these guidelines (see text). Concentrations in mg metal/kg sediment (ppm) dry weight. Station locations from Figure 1. Note different scales for mercury (right vertical axis) and the other metals.

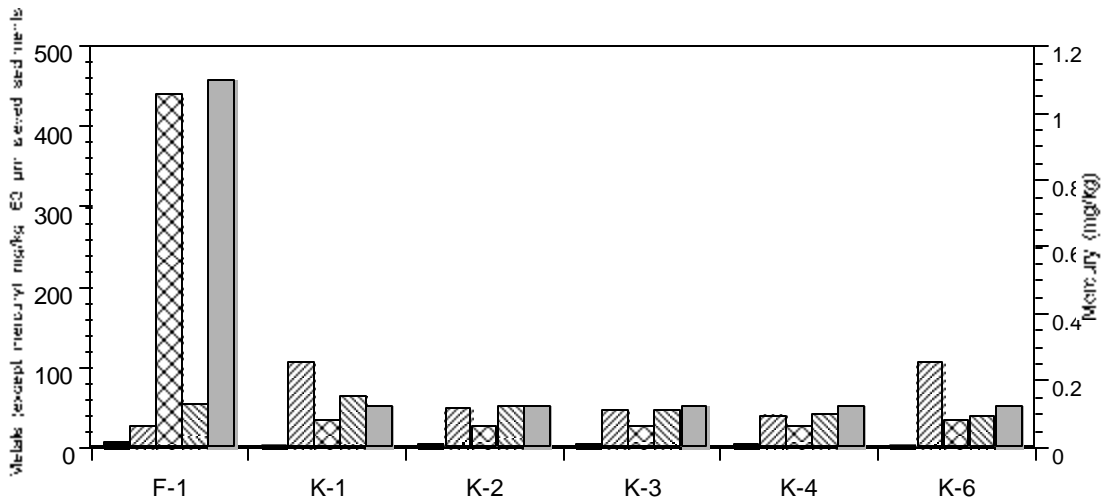


Figure F-2. Distribution of metals in sediments sieved through a 63 µm sieve from locations in the Kirtley watershed and from unmined upper Freeman Creek (reference). Concentrations in mg metal/kg sediment (ppm) dry weight.

Table F-5. Concentrations of metals in Kirtley Creek sieved sediment samples (mg/kg dry weight)

Location	Station	Type	As	Cu	Pb	Hg	Zn
Freeman Cr (reference)	F-1	Sieved	5.4	26	441	1.1	53
Lower Kirtley, above road	F-4	Sieved	4.1	40	26	<0.25	42
Upper Kirtley, at confluence	K-1	Sieved	2.4	107	35	0.25	65
Middle Kirtley, at lower placer	K-2	Sieved	3.5	48	27	<0.25	52
Middle Kirtley, below placer	K-3	Sieved	3.4	46	26	<0.25	47
Lower Kirtley, below road	K-6	Sieved	2.2	107	35	<0.25	39
Biological effects unlikely (ER-L)			NA	NA	NA	NA	NA
Biological effects probable (ER-M)			NA	NA	NA	NA	NA

Data Analysis and Interpretation

Data from test sites will be compared to regional and upstream background concentrations. The survey does not use statistical sampling design, therefore patterns will be identified by simply graphing the data. A 100% relative increase in reference to test concentrations will be considered evidence of anthropogenic enrichment of metals in sediments.

Sediment is an important exposure pathway for all forms of mercury to aquatic organisms. Mercury concentrations in sediment have been correlated with concentrations in or effects to benthic invertebrates. However, many investigators have reported no correlation between sediment and tissue concentrations of mercury for higher-trophic level species (Beckvar et al 1996). Therefore, for this survey, metals concentrations will be compared to a commonly used guideline for screening contaminated sediments, the National Status and Trends program Effects Range approach. The effects range approach uses effects range low and median values (ERL and ERM). The ERL and ERM are the lower (10th percentile) and median of the study concentrations associated with toxic effects in a large number of studies. In other words, the ERL is the low end of the range of concentrations where effects may be expected. Most sites with concentrations above the ERM would be expected to have adverse effects to benthic organisms. The ERL and ERM for mercury are 0.15 and 0.71 mg/kg dry weight sediment respectively (Beckvar et al. 1996, Long et al. 1995). No nationally accepted sediment quality values have been developed. However, the Effects Range approach of Long et al. (1995) was developed from a large database of the incidence of adverse biological effects and bulk sediment concentrations, and has performed well when compared with other methods (Long et al. 1998). While these SQVs were developed for marine sediments, the performance of these SQVs were similar to other values considered for protection of freshwater sediments in Washington state (Cubbage and Batts 1995).

Recommendations

Since mercury and other metal concentrations below the placered area were similar to upstream concentrations and below the median sediment quality values, above which effects would be expected, no further action is anticipated.